Development of a Draft Decision Tool to Evaluate Proposals for Change in SSL Protection Measures

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Resource Decision Support

1

This presentation includes

- **Introduction**

- **Methods – the Analytic Hierarchy Process**

  - **Summary of AHP theory**

  - **Application to the problem**

- **Results**

- **Suggestions for Implementation**

- **Remaining Issues**

Introduction

- **Mission:**
  - Build upon previous efforts to develop a rational approach to evaluating proposed changes in fishing regulations for P. cod, pollock, and Atka mackeral in the BS/AI and GOA, put in place to protect the SSL and their prey.

- **Assumptions:**
  - The recent BiOp postulates that fisheries have contributed to the decline in SSL numbers, probably by reducing prey.

  - Work proceeded with the assumption there is a relationship between fish harvest and nutritional balance of the SSL, although this does not imply the SSLMC concurs with this assumption.

Methods

- **Approach**
  - **1950's Systems Analysis: The whole of a complex system and the relationships of its parts is analyzed**
  - **1970's: AHP applied in the fields of military science, medicine, engineering, policy, economics, business**
  - **1990's: AHP applied in the fields of fisheries, natural resource allocation and restoration**

Fisheries Applications of the AHP
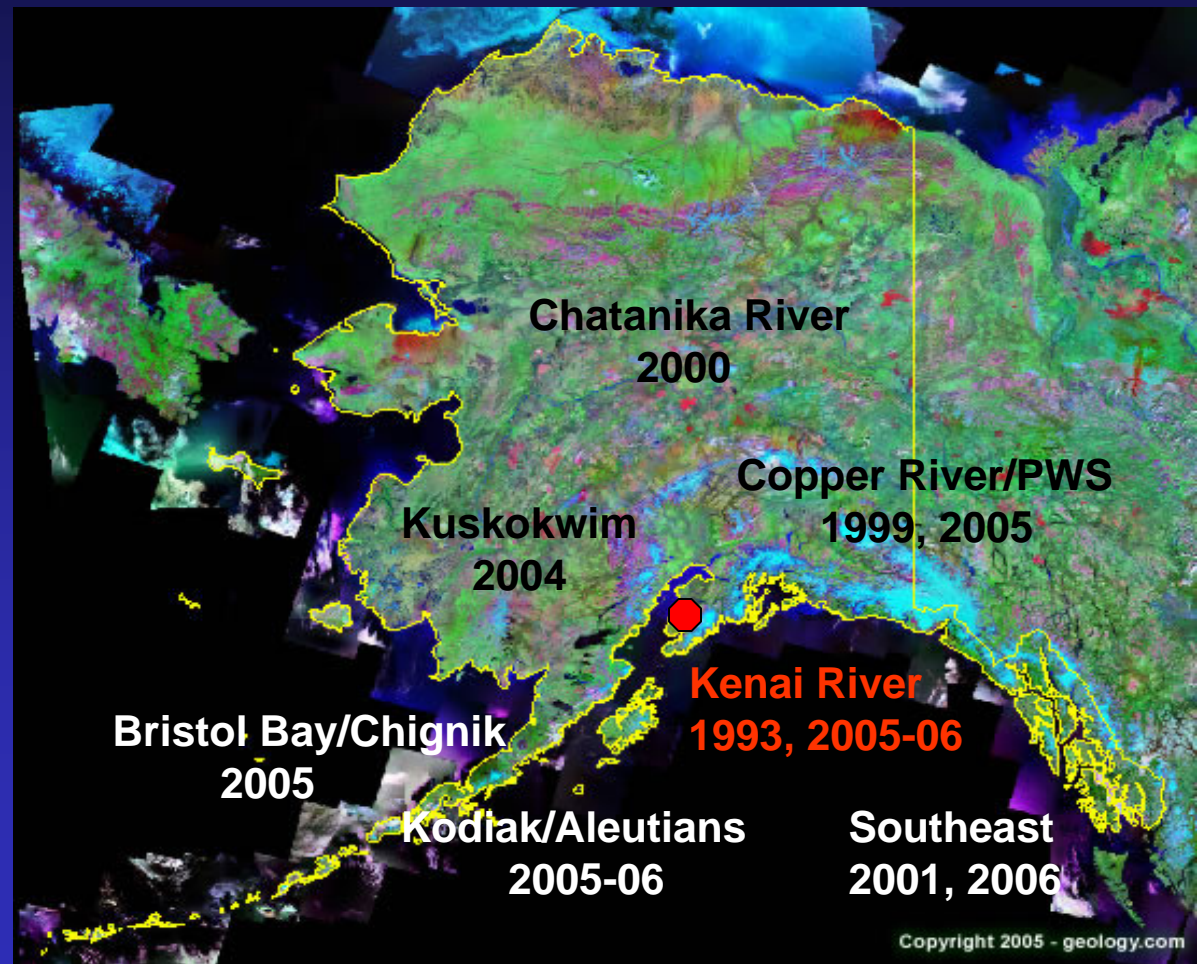
Strategic planning, research and management

Merritt & Criddle 1993

Merritt 1999, 2004

Merritt & Quinn 2000

Merritt & Skilbred 2001

USFWS 2005, 2006

Chatanika River
2000

Copper River/PWS
1999, 2005

Kuskokwim
2004

Kenai River
1993, 2005-06

Bristol Bay/Chignik
2005

Kodiak/Aleutians
2005-06

Southeast
2001, 2006

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Methods

- **Terms**
  - **Mother node, child**
  - **Dimension: Path along which impact can be measured**
  - **Variable: Components of proposals; child of dimension**
  - **Expert judgment: Previous relevant experience, supported by rational thought and knowledge**

Analytic Hierarchy Process

- **What is AHP?**
  - A systems approach for thinking developed by Dr. Tom Saaty: examine parts of the whole system and their linkages
  - A tool for integrating expert judgments

- **Why AHP?**
  - Clearly & concisely communicates the problem
  - Considers different points of view
  - Encourages explicit statements of preference, importance
  - Increases the likelihood of finding an optimal solution

- **How does it work?**
  - Structures the problem into a hierarchy
  - Prioritizes elements based on judgments

Goal: Improve information to sustain salmon populations

Define abundance and timing

Understand dynamics

Evaluate escapement

Need to estimate or index total run

What are migratory patterns?

What are impacts of fishing?
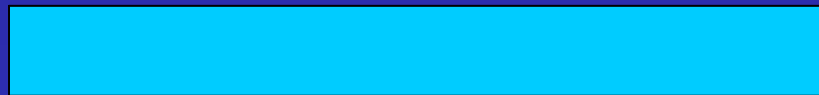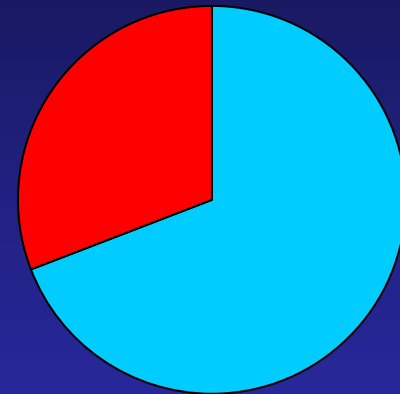
Need to document historic levels

Rating Scales

9   Extremely important

7   Very strong

5   Strong
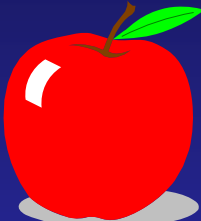
3   Moderate

1   Slight

Criteria for Weighting

Use criteria as guidelines to help judge importance (or preference) among elements in a group, such as:

- **Degree of sensitivity to impact**
- **Frequency of prey occurrence in the SSL diet**
- **Possible adverse effect on the SSL energy balance**
- **Potential for prey removal rate**

The SSLMC used supporting data when possible, either supplied by the NMFS-AFSC, found in the BiOp, or research reports.

Use Expert Judgment to Compare

Size Comparison	Apple A	Apple B	Apple C	Resulting Priority Eigenvector	Relative Size of Apple
Apple A	1	2	6	6/10	0.6
Apple B	1/2	1	3	3/10	0.3
Apple C	1/6	1/3	1	1/10	0.1

Sum column numbers.
Divide each number by column total to obtain a normalized matrix.
Obtain the average across each row.
This gives normalized relative priorities = approximate eigenvector.

11

Combining Judgments

- **Dissent & debate**
  - Explores alternative viewpoints
  - Debate can bring judgments closer through learning
  - Leads to understanding & cooperation
  - A well-informed person can effect change in belief !

- **When consensus is lacking:**
  - The geometric mean is the appropriate method for combining judgments made on a ratio scale
  - Disagreement is defined as differences in the rank order of importance. We also record the spread.

Structural Adjust

- **Approximate balance is sought and desired**
- **Structural imbalance is a reality in complex problems**
  - **Can lead to dilution of the weight of many variables under a single dimension**
  - **Adjustment feature in Expert Choice can be used to restore priorities to their intended proportion of weight**

Node	Intended weight	No. grandchildren	Math	Structural Adjusted weight
SSL site type by season and proximity…	.400	6 = .75	.400 x .75 = .3	(.3 x .604)/.35 ≈ .517
Fish species harvested…	.204	2 = .25	.204 x .25 = .05	(.05 x .604)/.35 ≈ .086
Total	.604	8 = 1.0	.35	.603

Results

The SSLMC identified two dimensions of the problem:

1. how fisheries affect the prey of the SSL, and

2. the needs of the SSL (where and when they are sensitive to reduced prey)

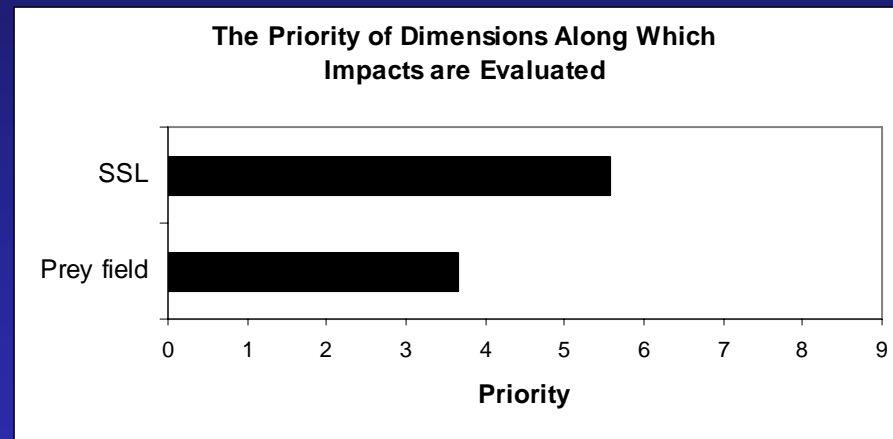The Priority of Dimensions Along Which Impacts are Evaluated

Figure 1. The relative priorities of SSL needs and fishing effects on SSL prey.

Dimensions

- **How fisheries affect the prey of the SSL. Concepts:**
  - Response of prey field to fishing
  - SSL's ability to capture and consume prey
  - Will prey availability be altered?
  - Will prey be measurably depleted?

- **The needs of the SSL. Concepts:**
  - Foraging ecology, reproductive behavior, energy balance
  - Fishing competition with juvenile SSL almost/recently weaned
  - Potential disturbance from fishing, including proximity

Table 1. The potential set of variables from proposed fishing regulation changes that are included in the model to evaluate impacts to the SSL and their prey.

Variable	Sub-units
1. Fish Species	a. Pacific cod b. Pollock c. Atka mackerel
2. TAC	The TAC is calculated for each fish species, for each region for a year
3. Fish Biomass	The biomass is estimated for each fish species, for each region for a year
4. Fishing duration	a. Pulse (TAC is taken in 3-10 days) b. Prolonged (TAC is spread out across time)
5. Geographic regions	a. Eastern Gulf of Alaska (EGOA) b. Central Gulf of Alaska (CGOA) c. Western Gulf of Alaska (WGOA) d. Eastern Aleutian Islands (EAI; includes the Bering Sea) e. Central Aleutian Islands (CAI) f. Western Aleutian Islands (WAI) g. Pribilof Islands
6. Seasons	a. Summer (the SSL breeding season, defined as May-September) b. Winter (non-breeding season, October-April)
7. SSL site types	a. Rookery b. Haulout c. other
8. Proximity to a site	a. 0-3 nm b. 3-10 nm c. 10-20 nm d. 20+ nm e. not critical habitat
9. Percent sites affected / region	a. 1-10% b. 11-25% c. 26-50% d. 51-75% e. 76-100%

Variables Applicable to the Prey Dimension

- **How best to account for fish removal relative to available biomass?**

  – A qualitative assessment of the ratio of TAC to fish biomass, per species, on a regional scale, per year

  – TAC/biomass can be scaled by degrees of impact to the prey field:

TAC/Biomass per species, per region	Weight of impact (score)
High TAC/Low Biomass	9
	8
	7
	6
	5
	4
	3
	2
Low TAC/High Biomass	1

For each proposal, the SSLMC must judge the expected proportion of removal, and score it according to the guide.

For a given fish species in a region, the NMFS-AFSC provided qualitative assessments of the TAC/Biomass ratio, projected to 2008

Ratio				
Species	Area	2006	2007	2008
Pollock	Eastern GOA	0.11	0.09	0.08
Pollock	Central GOA	0.11	0.09	0.08
Pollock	Western GOA	0.11	0.09	0.08
Pollock	Pribilof Islands	0.15	0.15	0.12
Pollock	Eastern AI	0.15	0.15	0.15
Pollock	Central AI	0.15	0.15	0.15
Pollock	Western AI	0.15	0.15	0.15
Pacific cod	Eastern GOA	0.12	0.11	0.07
Pacific cod	Central GOA	0.12	0.11	0.07
Pacific cod	Western GOA	0.12	0.11	0.07
Pacific cod	Pribilof Islands	0.15	0.12	0.10
Pacific cod	Eastern AI	0.15	0.12	0.10
Pacific cod	Central AI	0.15	0.12	0.10
Pacific cod	Western AI	0.15	0.12	0.10
Atka mackerel	Eastern GOA	n/a	n/a	n/a
Atka mackerel	Central GOA	n/a	n/a	n/a
Atka mackerel	Western GOA	n/a	n/a	n/a
Atka mackerel	Pribilof Islands	n/a	n/a	n/a
Atka mackerel	Eastern AI	0.11	0.18	0.14
Atka mackerel	Central AI	0.11	0.18	0.14
Atka mackerel	Western AI	0.11	0.18	0.14

18

Variables Applicable to the Prey Dimension

• **Fish removal rate must be discussed in relation to the duration of the removal**

Table 2. Judgments on the degree of impact (group geometric mean) that scenarios of removal rate and duration of fishing have on the SSL prey.

TAC/Biomass Score[a]	Duration of Fishery	Geometric Mean Group Score
9	Pulsed	8.74
	Prolonged	1.43
8	Pulsed	8.00
	Prolonged	1.41
7	Pulsed	6.90
	Prolonged	1.40
6	Pulsed	6.15
	Prolonged	1.38
5	Pulsed	5.36
	Prolonged	1.16
4	Pulsed	4.04
	Prolonged	1.12
3	Pulsed	3.15
	Prolonged	1.06
2	Pulsed	2.00
	Prolonged	1.06
1	Pulsed	1.19
	Prolonged	1.06

19

Variables Applicable to SSL Needs

- **How best to examine impacts related to SSL abundance and trend?**

  - **Sensitivity of site type, proximity of fishing activity in a given season, and percentage of sites in a given region affected is the best available proxy, because data on sites are more reliable**
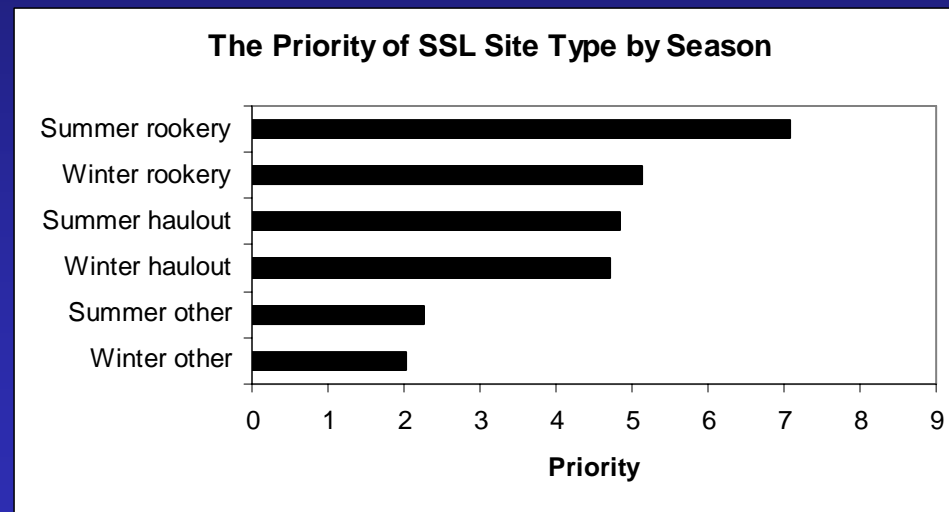

The Priority of SSL Site Type by Season

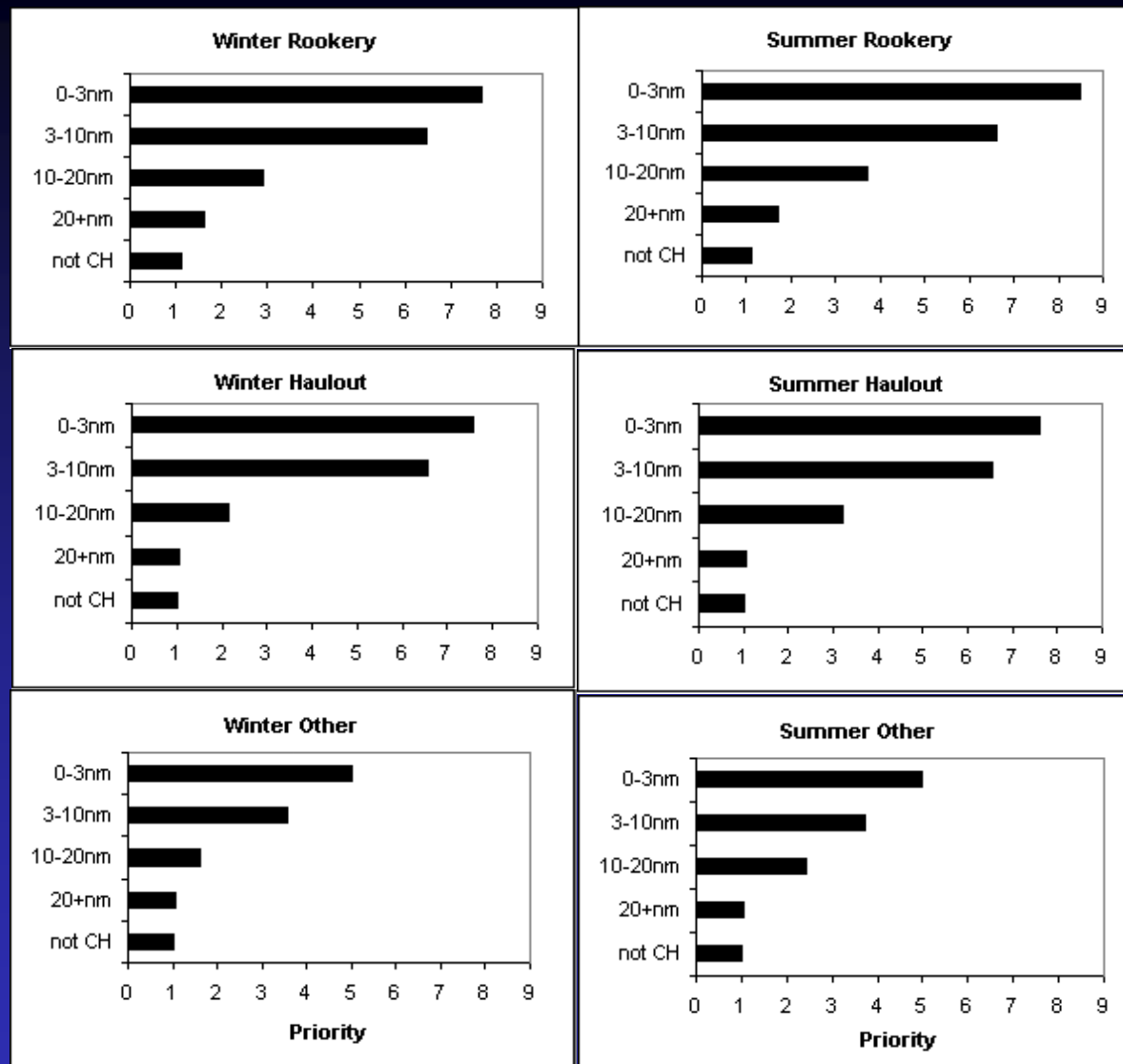**Figure 2. The priority of SSL site types, by season**

Figure 3. The sensitivity (priority) of a SSL site type to proximity of fishing, by season.
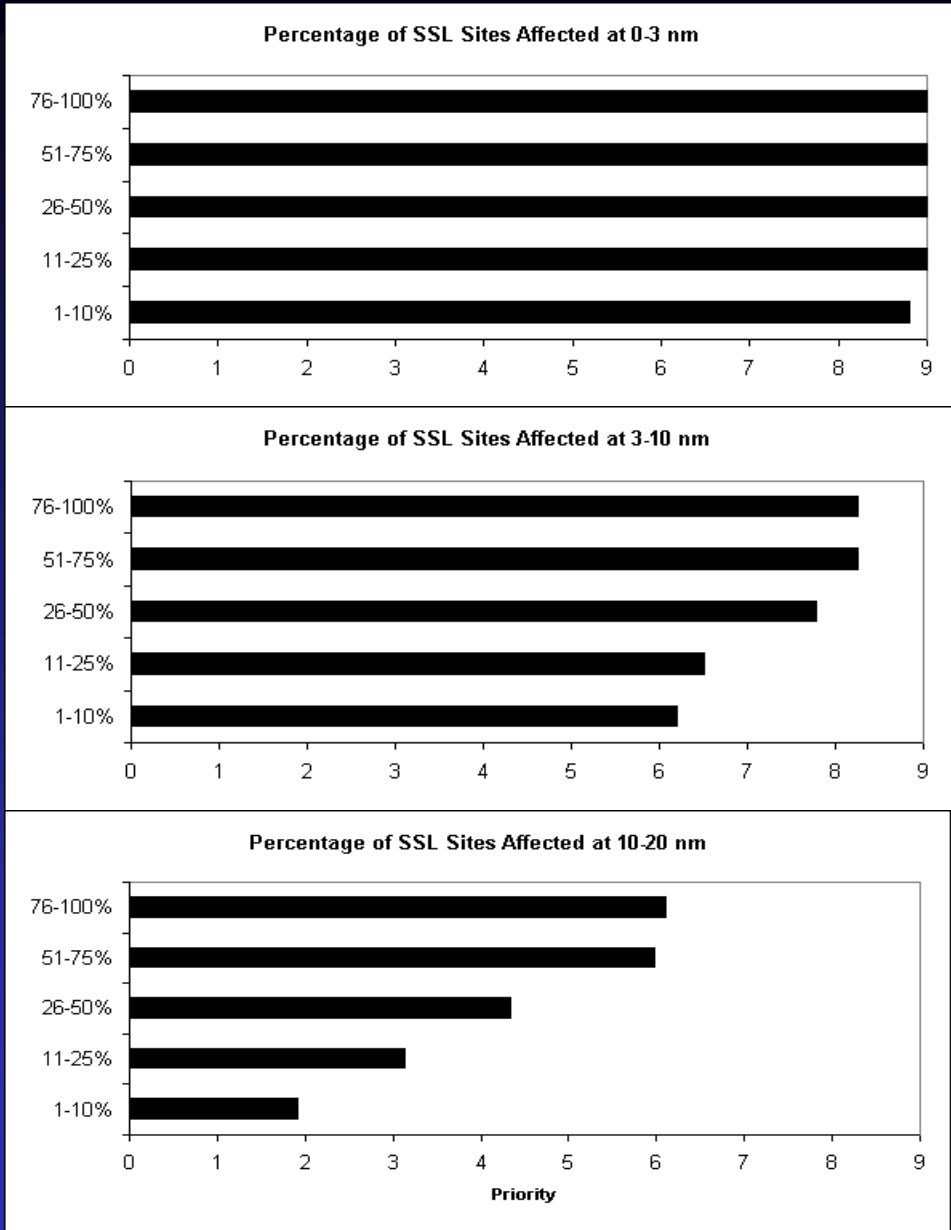
21

Figure 4.

The potential of adverse impact (priority) of a change in fishing, considering percentages of SSL sites affected in a region, and fishing in proximity to the sites.

Variables Applicable to SSL Needs

- **How best to consider the nutritional needs of the SSL?**

    - **Fish species harvested, in a given region, on a seasonal basis.**

    - **Scat research defining frequency of occurrence has identified Pacific cod, pollock and Atka mackerel as species of interest**

    - **The seven regions are defined in relation to the SSL draft revised recovery plan**
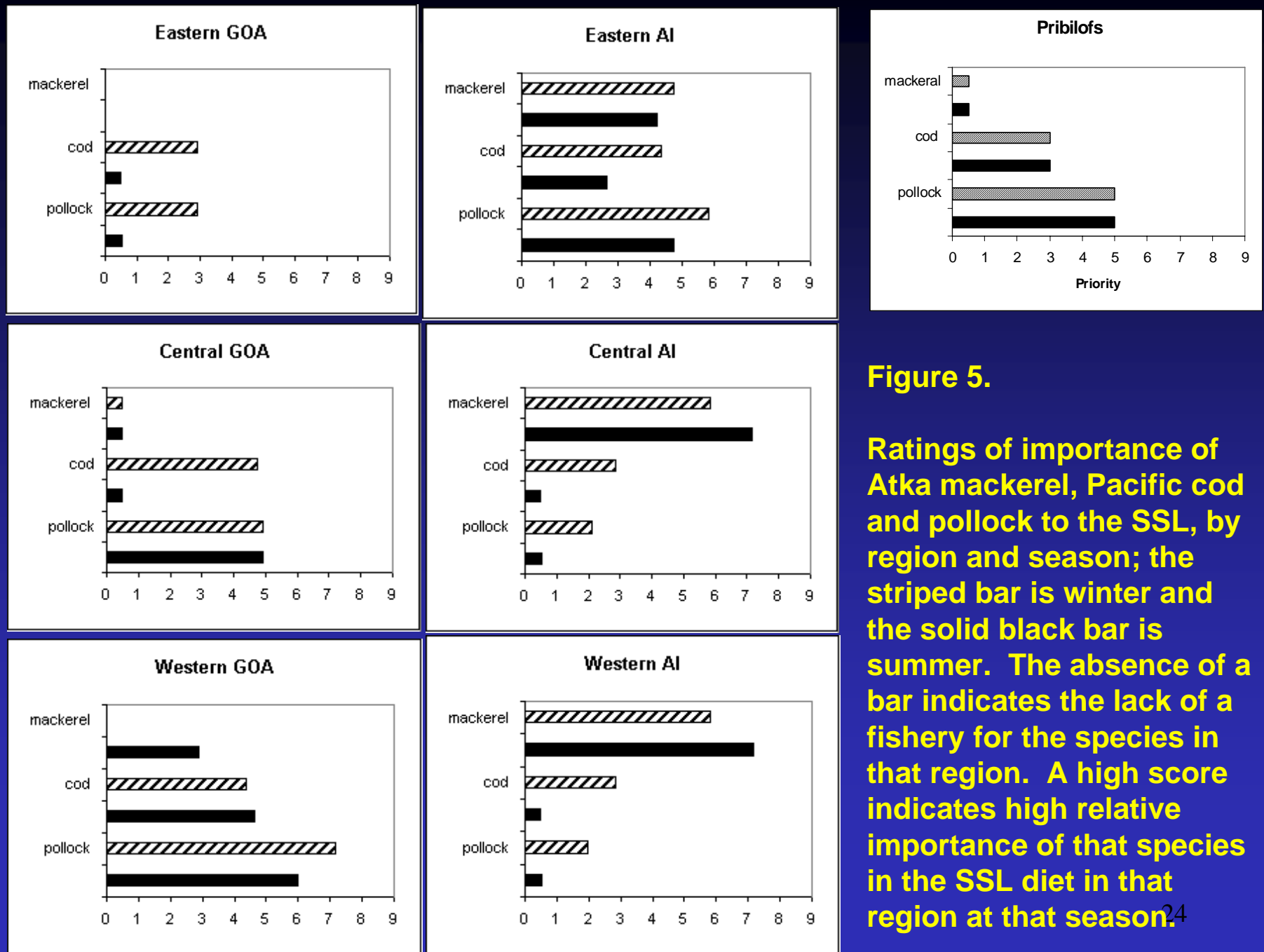
Figure 5.

Ratings of importance of Atka mackerel, Pacific cod and pollock to the SSL, by region and season; the striped bar is winter and the solid black bar is summer. The absence of a bar indicates the lack of a fishery for the species in that region. A high score indicates high relative importance of that species in the SSL diet in that region at that season.

24

Schematic of Hierarchy

- **Goal: Evaluating proposed changes in regulations (1.000)**
  - **How fisheries affect the prey of the SSL (0.396)**
    - **TAC/biomass**
    - **Duration**
  - **How fisheries affect the needs of the SSL (0.604)**
    - **SSL site type by season, proximity, and % affected (0.516)**
      - **Site by season**
      - **Proximity**
      - **Percent sites affected**
    - **Fish species harvested, by region and season (0.088)**
      - **Season**
      - **Region**
      - **Fish species**

Suggestions for Implementation

- **Against what metric should proposals be rated?**

  - **One approach is to compare the score of the proposed change to the current regulatory situation, to see the net effect of the change for that specific proposal**

	Tac/biomass ratio, prolonged	Season/EAI/cod	Season/SSL site type/ proximity/ % affected	Totals
Proposed	.008 (.448)	.002 (.505)	0 (.001)	.010 (.371)
Current	.010 (.552)	.002 (.495)	.005 (.999)	.017 (.629)

The proposal would shift fishing to outside the 20+nm zone, around "other" SSL sites; it is predicted there would be less impact that currently.

Suggestions for Implementation

- **How can we examine finer scale changes to regulations?**
  - We can bound the problem by the least and most possible impacts – the change lies somewhere between those scores

"Relax pollock trawl fishing closures around rookeries and haulouts in the western GOA area 620 between 155 degrees and 150 degrees 30 minutes. Allow pollock trawl fishing between 10 and 20 nm around those sites during the A and B seasons only."

	Tac/biomass ratio, prolonged	Season/ WGOA/ pollock	Season/SSL site type/ proximity/ % affected	Totals
Proposed-least impact (summer, haulout)	.010[a] (.500) [b]	.003 (.500)	.002 (.999)	.015 (.536)
Current-least impact	.010 (.500)	.003 (.500)	0 (.001)	.013 (.464)
Proposed-most impact (winter, rookery)	.010 (.500)	.004 (.500)	.005 (.999)	.019 (.576)
Current-most impact	.010 (.500)	.004 (.500)	0 (.001)	.014 (.424)

Remaining Issues

1. **Structure the model for fine scale changes?**

    – **Option: bound the possible impacts (see example)**

2. **The SSLMC needs to review the TAC/biomass ratios provided by NMFS-AFSC.**

3. **Structure the model to account for diversity of prey other than pollock, Pacific cod, Atka mackerel.**

4. **The SSLMC may wish to re-visit definitions of pulsed and prolonged fisheries, and their ratings of possible impact to prey of SSL.**

5. **What process should be used to select the set of proposed regulatory changes that is least likely to hamper SSL recovery?**

6. **Benefits (or "credits") have not been formally included in the evaluation tool to date.**